

## 14 Feminism, Postcolonialism, Technoscience

Banu Subramaniam, Laura Foster, Sandra Harding, Deboleena Roy, and Kim TallBear

This chapter identifies an emerging cluster of work that brings together the intersecting concerns of science and technology studies (STS), feminist STS, and postcolonial STS.

We begin by identifying a few of the central themes in each field and then introduce an emerging cluster of scholarship that works across all three. We then discuss three recent themes that highlight the key issues for STS: (1) critiques of colonial science and its hierarchies of gender/race/class, (2) Latin American decolonial theory and its feminist insights, and (3) how indigenous peoples' knowledge challenges all three of the above mentioned fields. We end with some reflections for the future of STS by arguing for more scholarly work that engages with all three of these intersecting fields. We believe that this is important for the field of STS because a singular focus on gender, race, coloniality, or indigeneity alone leaves numerous gaps in our understanding of the co-constitution of science and society.

### **Studying Science, Studying Society: The Importance of Feminist Postcolonial STS**

Feminist STS, postcolonial STS, and STS itself are all recognized research fields with powerful theoretical and methodological projects. Lively literatures in postcolonial and feminist STS have produced valuable insights. Yet, work that draws upon the fundamental insights of all three remains underexplored and theorized. In this essay, we examine emerging scholarship that brings these three fields together, exploring some of their common themes and tensions. The emerging work is heterogeneous (as is work in the three constituent fields), fluid, porous, and polyvocal and defies simplified definitions or categories. Bringing these fields together is important for developing more robust accounts of the co-constitution of science and society.

STS asks how societies, on the one hand, and their technosciences, on the other, shape each other in any particular historical era. A central approach in STS is to examine these relationships through practices of co-production; that is, we cannot study

science or society in isolation; we must always understand them as mutually producing each other and thus as constitutive of each other. In doing so, scholars ask how historically situated relationships of science and society co-produce new forms of knowledge production, as well as understandings of the social order (Jasanoff 2004; Reardon 2005; Shapin and Schaffer 1985). Thus influential STS projects have focused on sociologies of scientific knowledge (Collins 1983; Gieryn 1982), networks of human and nonhuman actors (Callon 1986; Latour 1987, 2004), technological artifacts (MacKenzie and Wajcman 1985; Pinch and Bijker 1984), boundary objects (Clarke and Casper 1996; Fujimura 1992; Star and Griesemer 1989), genetic technologies (Duster 2003; Franklin, Lury, and Stacey 2000; Rabinow 1999; Reardon 2005; Sunder Rajan 2006) and more. Feminist scholars contribute much to this work, bringing attention to how gender, inequality, and power figure centrally within relationships of science and society. Similarly, postcolonial STS demonstrates that science is best understood as co-constituted with colonialism (Anderson 2002; Anderson and Adams 2008; McNeil 2005; Seth 2009). Science and technology, it argues, is best understood as "sciences of empire" (Schiebinger 2004), and indeed almost all modern science should be understood as "science in a colonial context" (Seth 2009). A singular focus on gender, race, indigeneity, or coloniality however leaves gaps in our understanding of the co-constitution of science and society; therefore it becomes important to draw upon insights from all three fields of feminist STS, postcolonial STS, and STS.

Feminist STS has examined how scientific knowledge does not equally benefit everyone; it produces even more unequal social relations in significant respects, thus emphasizing the need for new ways of producing science. The work that emerged from the women's movements of the 1970s focused mainly on five questions. Where were the women in the history and present practices of technosciences? How did applications and technologies of technosciences affect women and our conceptions of gender, race, and sexuality? What should be feminist priorities for scientific and technical education for a more socially just world? What should be the feminist research priorities in natural and social sciences? What should more adequate epistemologies, ontologies, and philosophies of science look like? Early and more recent review essays provide valuable analyses of how such questions have been pursued in different research disciplines and political contexts (Harding 1986; Schiebinger 1987). Today many of these questions have actually reached top levels of science policy in the United States as well as in many other countries around the globe.<sup>1</sup>

As a product of the women's movements, feminist STS engaged more directly with social justice issues than did STS. Carolyn Merchant's influential 1980 work *The Death of Nature* in fact begins from the social concerns of women's liberation and ecology

movements (Merchant 1980). Organizations such as the Boston Women's Health Collective and SisterSong Women of Color Reproductive Justice Collective also take different strategies to increase the participation, access, and advocacy of patients historically marginalized within the health care system.

Yet feminist STS is by no means a unified, coherent, or complete area of study. Questions about women in science and about the gendering of science, although related, often do not overlap in their foci. The former questions are accused of failing to challenge historical and epistemological assumptions of science, while the latter are charged with implementing simplistic understandings of scientific practice. Additionally many "northern" feminist STS projects do not address colonialism and imperialism, while leaving indigenous peoples and their knowledge achievements and needs unrecognized (Harding 2008, 103).

Postcolonial STS focuses on colonialisms, their aftermaths, and how these are co-produced with a diversity of technoscience projects. Warwick Anderson writes that the term *postcolonial* "refers both to new configurations of technoscience and to the critical modes of analysis that identify them" (Anderson 2002, 643). Yet activists and scholars have been questioning the usefulness of the term for understanding, for instance, Latin America with its differing colonial histories (Medina, Marques, and Holmes 2014; Moraña, Dussel, Cuato, and Jáuregai 2008), and the diverse situations of indigenous/aboriginal groups around the globe. Recent special journal issues and edited collections have called for understandings of technosciences that account for colonial histories and postcolonial conditions (Anderson 2002; Harding 2011; McNeil 2005; Medina, Marques, and Holmes 2014; Phalkey 2013; Schiebinger 2005a; Seth 2009). This field, too, has rapidly expanded. Its distinctive focuses include contradictory spaces of postcolonial technoscience (Abraham 2006; Anderson and Adams 2008; Hecht 2012), histories of colonial expansion (Brockway 1979; Cañizares-Esguerra 2006; Schiebinger 2004; Tilley 2011), indigenous knowledge systems (Verran 2002; Watson-Verran and Turnbull 1995), and the circulation of technology within postcolonial technoscience projects (Crow and Carney 2013; de Laet and Mol 2000; Marques 2012). Scholars have explored the production of counter histories of Western science, the residues and reinventions of colonial science, reevaluations of traditional knowledge, and the development of alternative technoscience projects (Harding 2011). In later sections we identify some of the important additional insights that have emerged from anticolonial tendencies that focus on Spanish and Portuguese colonialism in the Americas, and those that focus on indigenous/aboriginal situations around the globe.

Similar to feminist STS, postcolonial STS also emerged from social justice movements of the 1960s and 1970s. Postcolonial STS took shape as newly independent states

began establishing their own science research and education programs. Both argue that science is not value free or, insofar as that is a requirement, objective, and that Western modern technosciences tend to distribute their benefits primarily to already well-resourced groups and their costs to economically and politically vulnerable groups. Western epistemologies of science have been used to justify the oppression of both kinds of marginalized groups (Harding 2009, 403). Both fields also call for recognition of multiple scientific traditions and for engagement with how those historically characterized as “other” produce valuably different ways of knowing (ibid., 403). Postcolonial STS differs however in its primary attention to colonialism and imperialism, leaving gender often unacknowledged (ibid., 406). Feminist STS shares similar limitations in its lack of attention to relations of colonialism and indigeneity (ibid., 406).

To address these limitations, scholars have begun exploring the conjunctions of STS, feminist STS, and postcolonial STS. Theorists such as Donna Haraway (1989), Sandra Harding (1986), Mary Louise Pratt (1992), Londa Schiebinger (1989), Vandana Shiva (1997), and Sharon Traweek (1988) defined important projects at these intersections. Contributions have also been made through feminist work on Third World development, which critique patriarchal and colonial science projects as well as basic Enlightenment assumptions undergirding modern Western sciences (Braidotti 1994; Shiva and Moser 1995; Visvanathan et al. 2011).

Drawing upon these legacies, recent scholarship continues to interrogate and develop new directions in these three conjoined fields (Benjamin 2009; Carney 2001; Foster 2016; Harding 2015; Hayden 2003; Philip 2004; Pollock 2014; Reardon 2005; Reardon and TallBear 2012; Roy and Subramaniam 2016; Subramaniam 2013, 2014; TallBear 2013b). It examines issues of science and technology of political concern to women in the global south and those who are considered “other” in the global north, including issues of environment, development, corporatization, and militarism. Additionally, it analyzes the science and technology traditions of non-European cultures and how colonial histories have and continue to shape European and American science and technology in new ways. It considers gendered social relations as always implicated within colonialism and imperialism, avoiding privileging gender as the sole site of analysis. Relations of power such as race, indigeneity, and settler colonialism are always deemed important and equally relevant. It also interrogates the term *postcolonial* more broadly as signifying a temporal moment, political condition, theoretical critique, subjectivity, and counter politic.

While such emerging scholarship has produced valuable key insights, this chapter focuses on more recent scholarship to show how issues of gender, race, coloniality, and indigeneity simultaneously come to the forefront, thus demonstrating the importance

of drawing upon feminist STS, postcolonial STS, and STS to provide new ways of understanding how the co-constitution of science and society shapes and is shaped by relations of power and inequality.

### Colonial Legacies: Colonization, Racism, Sexism, and Science

Although many feminist analyses of science might have begun with a focus on questions related to gender alone, many feminist scholars quickly learned to appreciate the mutual imbrication of the category of gender with those of race, class, age, sexual orientation, ability, and other categories of classification. Feminists of color and postcolonial feminist scholars have been quick to point out that it is *specific bodies* that have not only served as the objects of scientific inquiry but also as the *raw materials* needed for the “manufacture” of modern Western scientific theories and knowledge claims. Together these disciplines have brought to light evidence that many modern Western scientific theories, particularly the creation of scientific classification and taxonomical systems, have been built upon perceived differences identified in the bodies and lives of gendered, raced, classed, and colonized subjects. Drawing upon key examples, this section highlights the entangled histories of gender/race/class hierarchies and coloniality.

### Modern Sciences and Their Colonial Encounters

Postcolonial scholars have suggested that naturalists, anthropologists, and ethnographers of the colonial era used colonized spaces as their labs, exploiting so-called tribals along with the flora and fauna of their newly occupied lands as sources for data. The colonies, often viewed as being less civilized, served as the raw materials for the development of scientific theories of race and resources. It is not surprising, therefore, that scientific racism and scientific sexism flourished alongside colonial expansion during the late seventeenth and eighteenth centuries.<sup>2</sup> The bodies of individuals living in premodern conditions represented for European naturalists, such as the comparative anatomist George Cuvier, various points of evolutionary development along what was taken as a teleological view of human existence. The treatment of Saartjie Baartman for example, the “Hottentot Venus” who was taken from South Africa in 1810 and put on display as a “savage female” in London and Paris, remains a perfect case in point.<sup>3</sup> Following her death in 1815, Baartman’s remains were dissected by Cuvier and her brain, skeleton, and genitalia remained on display at the Musée de l’Homme in Paris until 1974. The question that scientists such as Cuvier at the time were interested in pursuing was whether or not some populations of humans they encountered should be classified as being human at all. Ideas of hierarchies of being were reinforced by a

scientific vision with the white Western heterosexual couple as the pinnacle of evolution (Markowitz 2001), lending credence to the logics of slavery and colonial domination. Indeed, Darwin and Malthus, two key figures that shaped the logics of evolution and population growth, developed their ideas during the height of colonial expansion and times when there would have been an influx of slaves and indentured laborers not only inhabiting newly colonized lands but also arriving on the shores of England.

Claims of modernity and its contrast with barbarianism and savagery also played an integral part in distinguishing Western scientific ideas and practices from local knowledge systems that were encountered in the colonies. We should remember that Darwin was writing at the beginning of seventy years of British colonialism in Africa and in the middle of two hundred years of colonialism in India. As Kavita Philip notes, "One of the effects of nineteenth-century scientific theories of non-Western nature and natives is the belief, persistent to this day, in an epistemological divide between universal science and local knowledge" (Philip 2004, 6). Through the extension of ideals from the Enlightenment era, the practices of modern Western science and scientific rationality were viewed as indications of civilization and social progress. By articulating what constituted the tools, technical aspects, and practices of "proper" modern scientific inquiry, scientists also simultaneously assigned local knowledges and practices in colonized nations to the status of backward, uncivilized, and premodern.

This legacy of scientific inquiry, which emerged as a result of colonial encounters, informs present-day struggles over indigenous knowledge, patent ownership, and benefit sharing. Laura Foster's work, for instance, examines how South African Indigenous San peoples, scientists, and growers animate multiple modalities of the Hoodia plant as natural, molecular, or cultivated to assert unequal modes of belonging in South Africa. Indigenous San, for instance, made strategic claims for benefit sharing with South African scientists in 2003 by articulating an affective kinship with Hoodia as a "natural" plant through gendered histories of its traditional use by both San men and women, thus asserting themselves as both modern and nonmodern subjects and simultaneously contesting and reinforcing colonial and colonial settler histories (Foster 2012, 2016). In doing so, San reconfigured themselves as producers of Hoodia knowledge in ways that changed the relationships between scientists and indigenous peoples, but at the same time they became stakeholders within Hoodia commercialization and its attachments to Hoodia as used only by San male hunters. Such relationships shifted though when the plant's patented molecular properties interacted with human bodies during clinical trials, foiling scientists' efforts to transform Hoodia into a weight-loss treatment and contributing to the termination of its commercialization in late 2008, thus making San claims for benefit sharing more difficult. Foster's work produces critical insights

for STS by accounting for how multiple modalities of human–nonhuman relations are entangled within gendered, indigenous, and colonial histories.

### Biological Differences and the Eugenic Project

Beginning with a central concept in evolutionary biology, variation, I have argued that this biological concept has been deeply intertwined with cultural ideas about diversity and difference since its very inception. Put starkly, evolutionary theories and models of variation owe their formulation to cultural debates around diversity and difference, culminating in their *eugenic scripts* that have haunted us ever since. (Subramaniam 2014, 224)

Many historians of science have traced the implementation of hierarchical political and racist measures of human worth to the emergence of scientific, and particularly, taxonomical classification systems, beginning with Carl Linnaeus's *Systema Naturae*, first published in 1735. For instance, Linnaeus's taxonomy drew on ideological beliefs about sex differences to scientifically categorize "male" and "female" parts in plants and flowers in traditional modes of human sexuality and the subordinate status of female gender roles (Schiebinger 1995). Early modern naturalists also used comparisons to female human anatomy to delineate distinctions between apes and humans. As Londa Schiebinger has suggested however, Linnaeus's classification of animals into six classes was dependent not only on notions of gender and female inferiority but also on ideas of racial inferiority. It is precisely within this "interplay between racial and sexual science" (1995, 116) that "[t]he body—stripped clean of history and culture as it was of clothes and often skin—became the touchstone of political right and social privileges" (1995, 116).

The entwined histories of racism and sexism can also be found in scientific theories of human intelligence. Differences in intellect, measured by questionable experimental methods, have made clear references to the undeveloped and premodern knowledge systems of "savages" (Gould 1996; Philip 2004) and human females historically understood as closely aligned with apes (Schiebinger 1995). These theories shaped the development of scientific research programs that were based on racist as well as eugenic principles and practices. For example, the "father of eugenics" Francis Galton, Darwin's half-cousin and contemporary, devoted his career to studying human differences and developing scientific measures for analyzing the inheritance of intellect.

This legacy of biological difference informs contemporary practices of a "new" eugenics, as articulated by Nobel Laureate James Watson (who has also shown interest in the biological underpinnings of intellect), which is based on the idea that humans should in fact desire better outcomes for the propagation of the human race. In his own words, Watson (2004, 401) describes his vision:

My view is that, despite the risks, we should give serious consideration to germ-line gene therapy. I only hope that the many biologists who share my opinion will stand tall in the debates to come and not be intimidated by the inevitable criticism. Some of us already know the pain of being tarred with the brush once reserved for eugenicists. But that is ultimately a small price to pay to redress genetic injustice. If such work be called eugenics, then I am a eugenicist.

From Francis Galton to our current atmosphere of scientific progress in genetics and molecular biology through innovations in directed evolution, we can witness the imprint that colonial encounters and legacies of racism and sexism have left behind on our scientific imaginations and practices. Such legacies inform contemporary debates over the reemergence of race as bio-genetic and its implications for racial hierarchies (Duster 2003; Koenig, Lee, and Richardson 2008; Roberts 2011). By conducting our analyses along interdisciplinary frameworks informed by feminist STS, postcolonial STS, and STS, we can begin to understand the history of our cultural and scientific obsessions with human differences.

#### A Focus on Latin America

Spanish and Portuguese colonialism in the Americas and its co-production with sciences and technologies have been almost entirely neglected in postcolonial STS, with its focus typically restricted to British and French colonialism in Asia and Africa (Medina, Marques, and Holmes 2014; Mignolo 2000; Rajão, Duque, and De' 2014). There are important similarities between the two literatures but also significant differences.<sup>4</sup> Feminist concerns deeply permeate the Latin American issues, though their relevance is not always fully addressed by these authors.

Thus one cannot today just "disseminate" to Latin America forms of social studies of science and technology and their feminist issues that were designed a few decades ago for other historical and social contexts. Such a practice will not access the richness and radicalness of Latin American projects. Moreover, it risks being experienced as one more example of residual coloniality. Colonial assumptions are by no means only a feature of the past. The experiences and practices of knowledge production in Latin America today continue to be shaped by their distinctive histories of colonialism and its aftermaths, including gender commitments.

This new focus is especially relevant now when institutional relations have been rapidly developing between STS organizations in North America and Europe, on the one hand, and in Latin America and other parts of the world, on the other. Essays in two publications were prepared to coincide with the 2014 Buenos Aires conference

cosponsored by the Society for Social Studies of Science (4S), and the Sociedad Latinoamericana de Estudios Sociales de la Ciencia y la Tecnología (ESOCITE). These provide innovative analyses of how modern Western sciences never, in fact, were disseminated to Latin America culturally intact. Rather they were always repositioned institutionally and in practice. Elements of them were "sutured" into local cultural, political, and material environments, which required innovations by the locals. Moreover, the Latin American innovations sometimes traveled to Europe and North America, in turn reshaping science and technology projects there (Medina, Marques, and Holmes 2014; Rajão, Duque, and De' 2014). One of these publications, "Voices from Within and Outside the South: Defying STS Epistemologies, Boundaries, and Theories" signals in its subtitle the question of how self-conscious of its own local character, of its parochiality, Northern STS itself is willing to become. That is, is Northern STS willing to give up its universalizing assumptions about its own endeavors when encountering the different and sometimes conflicting projects of Latin American STS? More generally, what could and should STS pluralism look like?

Pursuing such an issue is important also because these Latin American projects join a new world of STS analyses that start off from the different ways that science and technology projects and their societies co-produce each other around the globe. *East Asian Science, Technology and Society: An International Journal* began publication in 2007. In 2013, STS-Africa (sts-africa@lists.uni-halle.de) began to publish announcements of conferences, publications, jobs, and research initiatives around the globe focused on social studies of technosciences in or about Africa. Moreover, indigenous groups around the globe have been networking with one another. Their science and technology concerns are beginning to be recognized and institutionalized in United Nations and regional contexts. Several programs at the 2015 4S meetings were focused on such issues.<sup>5</sup> Clearly perspectives from diverse global colonialities, and resistances to them, are already beginning to transform what count as social and philosophic studies of sciences and technologies, as well as the choices, conceptions, and practices of diverse scientific and technology projects themselves. The distinctive history of state control of science and technology has led much of Latin America STS to focus on projects that increase social equality.<sup>6</sup> What are the central themes that appear in this Latin American literature?<sup>7</sup>

The modernity/coloniality research network that formed in the 1990s was influenced by many distinctively Latin American political impulses, most notably liberation theology, dependencia theory, the rise of indigenous social movements, and then of the World Social Forums.<sup>8</sup> These Decolonial<sup>9</sup> theorists argue that the connection

between the virtually simultaneous emergence of Spanish and Portuguese colonialism and early aspects of modernity was not merely the temporal accident implied by standard histories. Rather, Europeans invented modernity as an explicit response to the discovery of the “new world” of the Americas, populated with its savages and barbarians, “noble” or not.<sup>10</sup>

Modernity appears when Europe organizes the initial world-system and places itself at the center of world history over against a periphery equally constitutive of modernity . . . When one conceives modernity as part of a center-periphery system instead of an independent European phenomenon, the meanings of modernity, its origin, development, present crisis, and its postmodern antithesis change. (Dussel 1995, 9–10, 11)

In the case of both modernity and Iberian colonialism, scientific rationality and technical expertise were conceived as the motors of modernity and its progress.<sup>11</sup>

So modern Western sciences and technologies are implicated in the violent, oppressive, and destructive consequences of colonialism from 1492 on, not just beginning with the British occupation of India. European colonialism and its persistent residues and reinventions (“coloniality,” in these writings) constitute the “darker side of modernity” (Marques 2014; Mignolo 2011; Santos 2014).

Elite European women certainly benefitted in significant ways from colonialisms, and they were complicit in exercising its prerogatives. Yet, they did not participate in colonial decision making, nor did they receive the kinds of benefits of wealth and power that their brothers did (McClintock 1995; Pratt 2008). They suffered the imposition of new, restrictive standards of “proper” womanhood, namely, confinement to the newly invented sphere of private domesticity, which were constituted to contrast not only with the public sphere of men but also with the perceived degraded conditions of colonized women—indigenes, slaves, peasants.

As a number of feminist scholars have argued, violence and exploitation of colonized women’s sexuality and labor were crucial to the establishment of colonial control (Lugones 2010; McClintock 1995; Mendoza 2016; Pratt 2008). Colonialism could not succeed without the constant miscegenation that was Iberian colonial policy.<sup>12</sup> Thus gender and sexuality considerations should not be regarded as an optional addition to analyses of modernity and colonialism; they are an intrinsic element of such phenomena. Moreover, the Iberians legitimated and managed this constant miscegenation through the introduction of new, complex, and rigid pre-Darwinian racial categories about blood purity that persist in Latin America to this day. Thus new sciences establishing the natural foundations of social order—ones that were always simultaneously about race, gender, sexuality and class—were co-produced in both the colonized and the colonizing societies.

Meanwhile, getting from Europe to the Americas, traveling and living there, and getting back to Europe required new kinds of sciences and technologies. The voyagers needed astronomy of the Southern Hemisphere and better principles of cartography to enable them to chart their locations and routes across the Atlantic and in the Americas.<sup>13</sup> They needed better climatology and oceanography and better nautical engineering to enable the voyagers and their precious cargoes to survive the journeys. They needed knowledge of the dangerous or valuable new flora and fauna that they encountered, as well as social knowledge of the societies that they intended to conquer (Todorov 1984). Of course, they extracted virtually all of their knowledge of “natural history” from the indigenes: “discovery” consisted primarily of asking indigenes to share their knowledge. They needed the geology to enable them to extract the gold and silver that they found in Central America. It was three kinds of long-distance corporations that created these particular sciences: the Jesuits, the European trading companies, and the European empires (Harris 1998). These sciences were far more important to the creation of modern European science and technology than is usually acknowledged in the standard histories of science. Moreover, these sciences tend only rarely to advance through Kuhnian paradigm shifts. The classed and racialized gender relations between men in the development of colonial sciences have also begun to be examined (Cañizares-Esguerra 2006; Harris 2005; Schiebinger 2004, 2005a).

Both the Europeans and the indigenes they encountered had different economic, political, and social worlds in 1492 than did the British and the indigenes they encountered in the eighteenth century. Moreover, Spain and Portugal were Catholic monarchies. The conquistadors conceptualized the purpose of their colonization of the Americas and its “infidels” as economic, and importantly in the same religious terms that had directed the expulsion of the Moors (and Jews) from Granada in 1492; they were “unifying Jerusalem.” The virtually incomparable bravery and heroism of the conquistadors, hideous as its practices and consequences were, is comprehensible only as a religious mission.

Formal emancipation was virtually complete in the Americas by 1830, more than a century before it began to occur in Asia and Africa. But the newly emancipated countries had no models of what “independence” could or should be. They went through more than six decades of exhausting political uprising, coups, and shifting forms of government: an era of bold “social experiment” (Pratt 2008). French Comteian positivism, which had begun to appear in the early 1800s, appealed for different reasons to both conservatives and liberals, and eventually “saved” Mexico and Brazil from this chaos. Yet its adoption by governments faced with increasing resistance to its democratizing tendencies led to its transformation into a recipe for dictatorial technocracies

that vastly increased inequality. It then was completely rejected by 1910—decades before the German version emerged in the Vienna Circle (Gilson and Levinson 2013). Yet this history of (eventual) resistance to positivism can seem to haunt Latin American stances toward science and technology today—a topic for another time.

Finally, Andean highland indigenous movements, *Buen Vivir* in particular, managed to get their social and environmental agendas into the new national constitutions of Bolivia and Ecuador in 2005 and 2006. Here “nature” is a legal entity with rights that can be defended by advocates, much as children and the disabled have litigable rights. Debates over if, when, and how such epistemological, ontological, and political rights will prevail are currently at a high intensity (de la Cadena 2010; Gudynas 2011; Walsh 2010).

Finally, colonial practices of “just observing” and “just reporting what was seen” were often framed as having no consequences at all for what was subsequently done by others (such as militaries and corporations) with those observations and reports of them. Yet in fact colonial scientists were always also commenting on the value of local plants and indigenous practices for Europeans, and on how “nature” (including the indigenes) could be improved, as they collected samples and renamed indigenous plants and animals. Scientific exploration inherently makes use of “imperial eyes” (Pratt 2008). The positivist epoch in Mexico and Brazil was another form of this persistent attempt to define social progress in “innocent” terms that could be perceived as socially neutral with respect to conservative and liberal political impulses. Today’s conventional Western historians of science fully recognize that the single most effective generator of scientific achievements has been militarism. Yet there is a general disconnect between this acknowledged fact and appreciation of the role of colonial violence in advancing modern Western sciences. Establishing this disconnect has taken a lot of epistemic and ontological work on the part of Western scientific communities.

How can the social studies of science and technology acknowledge and work against this tendency? Latin Americans have been pondering such issues.<sup>14</sup>

### Nonmodern and Anticolonial Knowledge: Multiple Ways of Knowing, Being, and Doing

As we have seen, the notion of *postcolonial* knowledge production has its limitations and does not capture indigenous knowledge, both pre- and post-contact. Of course, we have only a very partial view on what constitutes *indigenous* knowledge from peoples who inhabited, say the Americas, pre-European arrival. However, in this section we address indigenous knowledge as a set of dynamic, articulated knowledge practices

that living indigenous peoples engage in. *Articulation* refers to borrowing, reinterpretation, and reconfiguration—the unhooking and recombining of different knowledges and practices into new cultural and social formations (Clifford 2001, 2003, 2007; Hall 1986a, 1986b; TallBear 2013a; Tsing 2007; Yeh 2007).

Thus indigenous peoples draw on both contemporary and more ancient traditions—in order to resist further decimation of their bodies, lands, and traditions. Beyond survival, indigenous peoples also engage with knowledge production in order to thrive in today’s world. Therefore, while indigenous knowledge draws on “traditional” knowledges, it is also in flux today as it no doubt always was, as the world in which indigenous peoples must live has shifted. The term *postcolonial* implies, of course, an *after* colonialism. At odds with this idea, however, is the way in which *indigenous* is defined. Indigenous peoples in the very fact of differentiating themselves from the settler state as first nations, tribal nations, first peoples, and the like, assert an explicitly political definition of indigeneity. *Indigenous* in this definition does not imply simply firstness in place (i.e., autochthony), cultural difference/isolation, or economic marginalization, although these are common components of how the state defines indigeneity that resonate in part with indigenous peoples. But for indigenous groups, adding the umbrella term to their people-specific identities (e.g., Maori, Cree, Dayak) helps organize their ongoing resistance to the authority of the genocidal and/or assimilative (settler) colonial state (TallBear 2013a). Because indigenous resistance to state hegemony is ongoing, indigenous peoples in the United States and Canada, for example, do not generally speak in terms that imply an *after* colonialism. Rather, settler state colonial practice continues in the very existence of those states.

Central to the production of the settler state and its ongoing projects has been knowledge production, or science. The project of the settler state has been organized around a trope of modernity versus savagery, including bringing Christianity, capitalism, agriculture, nuclear family, and so-called reasoned inquiry to civilize the savage lands and peoples of the Americas. Part of the right to civilize had been the right to inquire (Reardon and TallBear 2012; TallBear 2013b). The entire civilizational project has included not only rights of access to “nature” or “resources” that include indigenous lands and sacred sites but also the bodies, blood, and bones of indigenous and other marginalized subjects. Modernity also requires and in turn supports civilizational hierarchies of bodies and their knowledges with indigenous peoples being viewed as primitive, albeit sometimes the noble savage, in both regards.

Instead, we want to explore the idea of indigenous knowledges—in the past and in the present—as in part “nonmodern.” That is, indigenous knowledges can be seen as organized around not a uniquely human right to inquire but within systems in which

many diverse humans and nonhumans together constitute ways of knowing the world. In one example, Oceti Sakowij (Dakota, Lakota, or Nakota) people have referred to plants revealing their names and properties to patient or ready humans in dreams or visions (Howe and TallBear 2006). Similarly, the Cherokee, in addition to “the powers of observation” over long periods of time, sought “guidance through dreams or divination.” The “medicines of the new country were [after forced U.S. removal from previous lands] shown to the people through communication with animal spirits, the Little People, or even *Unehlanvhi*, the Creator” (Carroll 2015, 61). Whether or not the reader finds such ideas salient, the underlying principle is that such indigenous thinkers—both in the past and in the present—know that it is not simply the prerogative of humans alone to go about the world (re)naming and classifying all beings, including entities settler society deems to be inanimate. There are instead more multidirectional relationships of knowing and action at play between humans and nonhuman persons. On the other hand, modernity compels a more unidirectional human ordering and right to study and know other supposedly more primitive humans and nonhumans. The idea that there is a right to know the bodies of others cannot but involve non-consent, exploitation, and violence (Deloria [1969] 1988; Mosby 2013; Reverby 2009, 2011; Skloot 2010).

Another Dakota thinker provides a more detailed example that can help illustrate how indigenous peoples might constitute knowledge differently. Travis Erickson, a quarrier and expert carver at the Pipestone Quarries in southwestern Minnesota, United States, possesses expert knowledge about the red stone that is a key source for ceremonial pipes used by indigenous peoples throughout North America. The pipestone site is an important site at which tribes are thought to have gathered for hundreds of years—a place where custom dictates peaceful relations among humans. The stone was unsurprisingly renamed by whites for science. They called it *catlinite* after the nineteenth-century American artist George Catlin, who painted the site in 1836–1837. The assumed authority to rename is part of the colonial claim of ownership, a move to control through knowing. During that era human “explorers” moved into territories new to them, intending to name, classify, and report on the vast spaces of the continent. Erickson, who is approximately 50 years old, has in contrast spent his entire life living near to and working in the Pipestone quarries. Over decades he has engaged in diverse ways of interacting with stone and earth. When he describes how he acquires knowledge of the site, he is not the only agent in knowledge production. Erickson lives near the site year round and has one of the deepest quarries there. With such sustained exposure to the stone and after being taught by elders who also quarried for decades, he has acquired techniques for cutting through granite to get the soft pipestone beneath.

He also speaks of reading stories in the earth, histories of earth’s movements and the glaciers that brought rocks and bones and other items south to lodge in the soil there now. His “stories” seem to be in part co-constituted with geologists and other scientists own narratives of the geological history of Pipestone. The Pipestone National Monument is a U.S. Park Service site and so environmental and other scientists regularly also produce knowledge there.

Travis Erickson’s multiple ways of working demonstrate that important differences in indigenous ways of knowing, both in the past and the present, are not all classified completely or easily as nonmodern, however. Indigenous peoples also use so-called modern or Western knowledges to live meaningful lives even within settler society and to further contemporary indigenous political goals. Again, since indigeneity itself is an umbrella term added by indigenous peoples to their people-specific understandings of themselves and used to organize politically in a global context (TallBear 2013a), one can understand that “indigenous knowledge” can then also be understood as forms of knowledge that serve indigenous peoples’ survival, indeed their thriving, in (settler) colonial societies. These articulated indigenous knowledges might include older forms of knowledge acquisition such as knowledge through visions or dreams or intuitions combined with observations, learning-through-doing, and knowledge gleaned in conversations between, say, a quarrier and a geologist, both of whom interact closely with stone and earth. As Maggie Walter and Chris Andersen (2013, 17) explain in *Indigenous Statistics: A Qualitative Research Methodology*, “We argue for an accounting of modernity within first world Indigenous methodologies; we also argue against positioning Indigenous methodology dichotomously in opposition to Western frames and against grounding it in a concept of traditional knowledge and culture ‘outside of modernity’.”

Finally, while Erickson is one of the few indigenous thinkers who minimize their use of the words *spiritual* and *sacred*, his listening and waiting sometimes for knowledge to come to him and his recognition that humans are not the only agents brings to mind a final problem with so-called modern knowledge: that is, its inability to engage with immaterial forces such as “spirits.” While recent critical approaches to animal studies seek to dismantle hierarchies in the relationships of “Westerners” with their nonhuman others, they have largely restricted themselves to beings that live—defining beings organismically, for example, dogs, bears, mushrooms, microorganisms (e.g., Kirksey 2014). Such work is methodologically and ethically innovative in that it highlights how organisms’ livelihoods are co-constituted with cultural, political, and economic forces. But these approaches cannot fully contain indigenous standpoints. Indigenous peoples have not forgotten that nonhumans are agential beings engaged in social relations in which human lives are intimately and intricately shaped. To that end, recent

work in the “new materialisms” is complementary as it attempts sometimes to capture the vibrancy and forces in human lives of nonliving things (a chair, a mineral), but in ways that, similarly to multi- or interspecies thinkers, divides the world into life and not life organismically defined (e.g., Bennett 2010; Chen 2012). But for many indigenous peoples, the other-than-human beings that shape their lives might also include objects and force” such as stones, thunder, stars, or spirits (for lack of a better word) (Shorter 2012; TallBear 2015). Recognition of the ability of nonhumans to actively shape human lives serves as an epistemological and ethical challenge to settler colonialism and its ordering (say into human versus animal), management of, and violence toward nonhuman others.

### Toward the Future

This brief account highlights the mutual importance of STS, feminist STS, and postcolonial STS, as well as the fault lines and limitations of each. Feminist STS often marginalizes questions of race and postcoloniality. Postcolonial STS pays little attention to the complexities of gender and indigeneity. We have also stressed that colonial histories in different parts of the world and their subsequent resistance have taken different shapes, leading to related but distinct theories of postcoloniality and decoloniality. Issues of gender, race, postcoloniality, and indigeneity remain at the peripheries of STS. One of the central arguments we have been making is that questions of gender, race, coloniality, and indigeneity are not optional variables or analytics that each field can choose whether to consider. In bringing together central insights of feminism, postcolonialism, and the social studies of technosciences, we can begin to appreciate the inextricable interconnections of the three.

It is worth noting two other social movements that are shifting the narratives of technosciences and their practitioners, albeit in different ways to indigenous peoples’ projects. As patient groups and consumers have laid claim to science through political mobilization as well as DIY science movements, science has moved from the laboratory and the hallways of power into an era of citizen-driven science (Benjamin 2013; Epstein 1996; Hess 2011). We have also seen shifts in geopolitics, as emerging economies have thrown their national economies into state-supported national genomic projects, resulting in new configurations of “genomic nationalism” (Benjamin 2009). Both projects depend on entangling race, gender, and narratives of technoscience. As colonial and postcolonial STS remind us, science is not a Western invention that has slowly diffused to the other societies around the globe, thereby ushering them into the glorious world of modernity (Basalla 1967; Prasad 2008; Raina 1999). Rather, from its

beginnings, science and the European modernity of which it was a central part were intimately involved with coloniality and empire. Thus modern Western technosciences were not developed outside of politics; rather they were at the heart of colonialism’s political ideologies and institutional structures (Baber 1996; Prakash 1999).

Elaborating the logic of difference—of sex, gender, race, sexuality—was central to the operations of colonial government. Science played a critical role in naturalizing such logics of difference. In such a reframing, we cannot tell the story of colonialism without attention to the roles of science and of gender hierarchies, or narrate a history of Western science without attention to coloniality and gender hierarchies, or a history of gender without attention to science and colonialism. Yet contemporary histories also remind us that colonized nations and their indigenes have never been the passive victims of colonial rule but rather vibrant actors with agency, active engagement, and resistance, albeit in situations with grossly unequal power.

What emerges in these new studies is an entangled history of gender hierarchies and coloniality, in which modern Western technosciences have all too often provided powerful resources. Today we need to understand the unequal, varied, and complex practices of technosciences across the globe as they encounter the “sticky materiality of practical encounters” (Tsing 2005, 1). We need to move to more mobile, fluid, and “entangled” (Prasad 2014) models of feminist STS, postcolonial STS, and STS whether they are through “contact zones” (Pratt 1992), “a moving metropolis” (MacLeod 2000), or “science as circulation” (Raj 2013). In the case of the European technosciences, these alternative metaphors shift our understanding from the old linear diffusion model from west to east, to a more vibrant and dynamic account of the long and varied travels and interlocutions of technosciences, gender, and colonialities. The same is the case for our research disciplines that study such phenomena.

STS, feminist STS, and postcolonial/decolonial STS need one another to provide a richer account of the extensive travels of colonialism and colonial knowledge formations. It is in these shifts that one can find possibilities of new histories and new accounts of how the world, its peoples, our disciplines, and knowledges have *become* what they are. And from such accounts of becoming we can find ways and modes of *unbecoming* and becoming anew.

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### Notes

1. Londa Schiebinger's website on "Gendered Innovations in Science, Health & Medicine, Engineering, and Environment" ([genderedinnovations.stanford.edu](http://genderedinnovations.stanford.edu)) documents policy initiatives and conferences around the globe that address such issues.
2. This standard chronology of the origins of scientific racism is challenged (or at least expanded) by the Latin American decolonial claim that it was the arrival of the distinctive policies of Spanish and Portuguese coloniality in the Americas in 1492, two centuries earlier, that introduced systematic racial classifications to the world and that inextricably entangled racial and gender hierarchies in Latin America to this day, as will be discussed later.
3. The case of Saartjie Baartman also gives us pause and is indicative of the contradictory terrain in which a decolonial feminist STS is situated. Feminist scholars have recently questioned the continual use of Baartman to discuss colonial violence, arguing that to do so re-inscribes such violence. At the same time, contemporary indigenous Khoi and San peoples active in political mobilization to return the body of Baartman to South Africa in 2002 note the importance of making such histories known as they are critical for supporting San and Khoi efforts at self-determination. Yet, even the return of Baartman raised new questions as to who could speak for her and how. Emerging decolonial feminist STS work provides insights that bring such contradictory and complex tensions to the forefront.
4. See, for example, Rodriguez (2001).
5. For example, # 036 "Indigenous Knowledge Sovereignties and Scientific Research."
6. See Saldana (2006) and Vessuri (2006) for histories of science in Latin America, and Vessuri (1987) for the earliest survey of the social study of science in Latin America.
7. A huge proportion of the Latin American decolonial literature and its STS components is now in English, including many primary sources. This is the literature addressed here.
8. See Escobar (2010) for a review of the history and distinctive concerns of the modernity/coloniality network, including an extensive analysis of gender issues and the innovative treatment of nature.
9. This term is capitalized to distinguish this theoretical group from the more general use of the term.
10. But see Brotherston (2008) and Mann (2002) for recent evaluations of what the indigenes knew in 1491. Of course it is only in the "high modernity" of the eighteenth and nineteenth centuries that the sociological markers of modernity are fully established, such as public and

private spheres, and the disaggregation from the family of economic, political, education, and religious/moral institutions.

11. This is so even though Todorov (1984) and others have pointed out that Columbus was very much a medieval man. Cortes, on the other hand, already possessed distinctively modern characteristics. Of course, as a navigator, Columbus highly valued empirical observation.
12. Whether this was a practice of rape or consent may not be a meaningful distinction in the context of colonial inequalities.
13. See the discussion in Mignolo (2011, 78) of the first appearance of "globalization": a "god's eye" map of the known world.
14. In addition to earlier citations, see for example, Isasi-Diaz and Mendieta (2012); Maldonado-Torres (2012); Morana et al. (2008); and Santos (2014).

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**Fourth Edition**

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**Ulrike Felt**  
**Rayvon Fouché**  
**Clark A. Miller**  
**Laurel Smith-Doerr**

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## Contents

Preface ix

Acknowledgments xi

### Introduction 1

Ulrike Felt, Rayvon Fouché, Clark A. Miller, Laurel Smith-Doerr

### 1 Doing, Exploring, and Reflecting on Methods 27

Laurel Smith-Doerr

### 1 STS as Method 31

John Law

### 2 Rethinking Documents 59

Kalpna Shankar, David Hakken, and Carsten Østerlund

### 3 Intellectual and Practical Contributions of Scientometrics to STS 87

Sally Wyatt, Staša Milojević, Han Woo Park, and Loet Leydesdorff

### 4 Ethnomethodology, Video Analysis, and STS 113

Philippe Sormani, Morana Alač, Alain Bovet, and Christian Greiffenhagen

### 5 Art, Design, and Performance 139

Chris Salter, Regula Valérie Burri, and Joseph Dumit

### 6 Engaging, Designing, and Making Digital Systems 169

Janet Vertesi, David Ribes, Laura Forlano, Yanni Loukissas, and Marisa Leavitt Cohn

### 7 Experiments in Participation 195

Javier Lezaun, Noortje Marres, and Manuel Tironi

### 8 Making and Doing: Engagement and Reflexive Learning in STS 223

Gary Lee Downey and Teun Zuiderent-Jerak

- II Making Knowledge, People, and Societies 253**  
Ulrike Felt
- 9 Science and Democracy 259**  
Sheila Jasanoff
- 10 STS and Social Movements: Pasts and Futures 289**  
Steve Breyman, Nancy Campbell, Virginia Eubanks, and Abby Kinchy
- 11 Structural Inequality and the Politics of Science and Technology 319**  
David J. Hess, Sulfikar Amir, Scott Frickel, Daniel Lee Kleinman, Kelly Moore, and Logan D. A. Williams
- 12 Race and Science in the Twenty-First Century 349**  
Ramya M. Rajagopalan, Alondra Nelson, and Joan H. Fujimura
- 13 Sex, Gender, and Sexuality in Biomedicine 379**  
Jennifer R. Fishman, Laura Mamo, and Patrick R. Grzanka
- 14 Feminism, Postcolonialism, Technoscience 407**  
Banu Subramaniam, Laura Foster, Sandra Harding, Deboleena Roy, and Kim TallBear
- 15 Conceptualizing Imaginaries of Science, Technology, and Society 435**  
Maureen McNeil, Michael Arribas-Ayllon, Joan Haran, Adrian Mackenzie, and Richard Tutton
- 16 Performing and Governing the Future in Science and Technology 465**  
Kornelia Konrad, Harro van Lente, Christopher Groves, and Cynthia Selin
- III Sociotechnological (Re-)configurations 495**  
Rayvon Fouché
- 17 Reconceptualizing Users through Enriching Ethnography 501**  
Lisa-Jo K. van den Scott, Carrie B. Sanders, and Antony J. Puddephatt
- 18 How Infrastructures Matter 529**  
Stephen C. Slota and Geoffrey C. Bowker
- 19 STS in the City 555**  
Ignacio Farías and Anders Blok
- 20 The Sociotechnical Architecture of Information Networks 583**  
Hector Postigo and Casey O'Donnell
- 21 Machineries of Finance: Technologies and Sciences of Markets 609**  
Alex Preda

- 22 A Critical Theory of Technology 635**  
Andrew Feenberg
- 23 STS for Development 665**  
Aalok Khandekar, Koen Beumer, Annapurna Mamidipudi, Pankaj Sekhsaria, and Wiebe E. Bijker
- IV Organizing and Governing Science 695**  
Laurel Smith-Doerr
- 24 Gender, (In)equity, and the Scientific Workforce 701**  
Mary Frank Fox, Kjersten Bunker Whittington, and Marcela Linková
- 25 The Social and Epistemic Organization of Scientific Work 733**  
Edward J. Hackett, John N. Parker, Niki Vermeulen, and Bart Penders
- 26 Interactional Expertise 765**  
Harry Collins, Robert Evans, and Martin Weinel
- 27 Surveillance and Regulation of Laboratory Practices 793**  
Ruthanne Huising and Susan S. Silbey
- 28 Ethics as Governance in Genomics and Beyond 823**  
Stephen Hilgartner, Barbara Prainsack, and J. Benjamin Hurlbut
- 29 Responsible Research and Innovation 853**  
Jack Stilgoe and David H. Guston
- 30 Reframing Science Communication 881**  
Maja Horst, Sarah R. Davies, and Alan Irwin
- V Engaging with Societal Challenges 909**  
Clark A. Miller
- 31 Aging: The Sociomaterial Constitution of Later Life 915**  
Kelly Joyce, Alexander Peine, Louis Neven, and Florian Kohlbacher
- 32 Agricultural Systems: Co-producing Knowledge and Food 943**  
Alastair Iles, Garrett Graddy-Lovelace, Maywa Montenegro, and Ryan Galt
- 33 Knowledge and Security 973**  
Kathleen M. Vogel, Brian Balmer, Sam Weiss Evans, Inga Kroener, Miwao Matsumoto, and Brian Rappert

- 34 Researching Disaster from an STS Perspective 1003**  
Kim Fortun, Scott Gabriel Knowles, Vivian Choi, Paul Jobin, Miwao Matsumoto,  
Pedro de la Torre III, Max Liboiron, and Luis Felipe R. Murillo
- 35 Environmental Justice: Knowledge, Technology, and Expertise 1029**  
Gwen Ottinger, Javiera Barandiarán, and Aya H. Kimura
- 36 The Making of Global Environmental Science and Politics 1059**  
Silke Beck, Tim Forsyth, Pia M. Kohler, Myanna Lahsen, and Martin Mahony
- Contributors 1087  
Name Index 1111  
Subject Index 1151

## Preface

Welcome to the fourth edition of the *Handbook of Science and Technology Studies*! We live in a world in which the technosciences have become a dominant mode of knowledge-making, with wide-ranging material and conceptual consequences. If you are relatively new to science and technology studies (STS), this substantial book and the interdisciplinary field that it landscapes (an apt metaphor adopted by the editors and elaborated in their introduction) can begin to answer your questions. Are you interested in understanding how the technical dimensions of science and technology are always enmeshed with their nontechnical dimensions? Might you be someone who feels compelled to analyze sciences and technologies critically, with the goal of questioning received assumptions and exploring new conceptualizations? Do you find yourself asking what the technosciences are for, and for whom, and imagining how they might be otherwise? Then this book is for you. Alternatively, if you are already deeply engaged with STS, this extraordinary collection of thematic articulations of the field will serve as an invaluable reference and further resource for your ongoing work.

Officially, it is the Society for Social Studies of Science (4S) that offers this handbook to all readers interested in the scholarship of STS, including what STS researchers and practitioners write, make, and do and the implications of our scholarly practices. Yet as the editors' thoughtful and reflexive introduction makes clear, 4S does so in recognition of its own limitations and with the collegial support of sister societies, researchers, and practitioners beyond its boundaries and across the planet. This handbook invites readers to find inspiration and, we hope, new directions in which to take STS projects, mobilizing relevant scholarly practices and infrastructures both already made and in the making.

On behalf of the 4S membership, we ask you to join us in thanking all of those scholars whose collective work brought this remarkable volume into being. Thanks go first to Kelly Moore, who as chair of the 4S Publications Committee translated formal procedural oversight into many days of managing complexity and offering generous